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SITE Technology Capsule

Terra-Kleen Solvent Extraction Technology

Introduction

In 1980, the U.S. Congress passed the Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA), also known as Superfund, which is committed to protecting human health and the environment from uncontrolled hazardous waste sites. CERCLA was amended by the Superfund Amendments and Reauthorization Act (SARA) in 1986. SARA mandates implementing permanent solutions and using alternative treatment technologies or resource recovery technologies, to the maximum extent possible, to clean up hazardous waste sites.

State and federal agencies and private organizations are now exploring a growing number of innovative technologies for treating hazardous wastes. The more than 1,200 sites on the National Priorities List involve a broad spectrum of physical, chemical, and environmental conditions requiring diverse remedial approaches

The U.S. Environmental Protection Agency (EPA) has focused on policy, technical, and informational issues related to exploring and applying new technologies to Superfund site remediation. One EPA initiative to accelerate the development, demonstration, and use of innovative technologies for site remediation is the Superfund Innovative Technology Evaluation (SITE) Program.

EPA SITE Technology Capsules summarize the latest information available on selected innovative treatment and site remediation technologies. The Capsules assist EPA remedial project managers, EPA on-scene coordinators, contractors, and other remedial managers in the evaluation of site-specific chemical and physical characteristics to determine a technology's applicability for site remediation.

This Capsule provides information on the Terra-Kleen solvent extraction technology, developed by Terra-Kleen Response Group Inc. (Terra-Kleen). Terra-Kleen claims that the technology is designed to remove organic compounds from soil, sludges, and sediments. In October 1993, the Terra-Kleen technology was evaluated by EPA's SITE Program during a treatability study on soils from three different sites; the technology was also evaluated in June 1994 during pilot-scale demonstration tests on soils from Naval Air Station North Island (NASNI). All soils treated were contaminated with polychlorinated biphenyls (PCB) in the commercial formulation of Aroclor 1260. Information in this Capsule presents specific soil and contaminant characteristics and results of the treatability study and the pilot-scale demonstration. Additional information on the implementation of a full-scale Terra-Kleen system to remediate soils contaminated with dichlorodiphenyldichloroethene (DDE), dichlorodiphenyltri-chloroethane (DDT), and dichlorodiphenyldichloroethane (DDD) at Naval Communication Station (NCS), Stockton, CA, is provided in the Technology Status section.

This Capsule presents the following technology information:

- Abstract
- Technology Description
- Technology Applicability
- Technology Limitations
- Process Residuals
- Site Requirements
- Performance Data
- Technology Status
- Source of Further Information

Abstract

Remediation of PCBs in soils has been difficult to implement on a full-scale, cost-effective basis. The Terra-Kleen solvent extraction system has overcome many of the soil handling, contaminant removal, and regulatory restrictions that have made it difficult to implement a cost-effective PCB soil treatment system.

The Terra-Kleen system is a batch process that operates at ambient temperatures and removes organic contaminants from

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soils using proprietary solvents. After soils are washed with solvent, contaminated solvent passes through a recovery unit, where contaminants are separated from the solvent and concentrated, reducing the contaminant volume for disposal. The reclaimed solvent is then reused in the process.

Terra-Kleen demonstrated the technology during a treatability study in October 1993 and a pilot-scale demonstration in June 1994. The demonstrations were conducted by the EPA SITE Program with the assistance of PRC Environmental Management, Inc. (PRC).

In October 1993, the SITE Program obtained 1-ton batches of soil from each of 3 PCB-contaminated sites and shipped the soil to Terra-Kleen's testing facility in Okmulgee, OK. Soils were obtained from Sites 4 and 6 at NASNI near San Diego, California, and from a third site in Anchorage, Alaska. Analyses of all demonstration soils revealed that Aroclor 1260 was the only PCB mixture present.

Successful removal of PCBs during the treatability study led to a pilot-scale demonstration at NASNI in June 1994. The Naval Environmental Leadership Program (NELP) contracted Terra-Kleen to treat 5 tons of soil from Site 4 at NASNI. An agreement between the SITE Program and NELP was also established to help implement the pilot-scale demonstration.

The primary objective of both the treatability study and pilot-scale demonstration was to determine the Terra-Kleen technology's effectiveness at removing PCBs from soil. The target treatment level for system evaluation was the Toxic Substance Control Act's (TSCA) incineration equivalency performance guidance level of 2 milligrams per kilogram (mg/kg) of PCBs in soil.

PCB removal from soils and solvent was documented using on-site and off-site analytical tests. During the treatability study, soil was analyzed on site for PCBs using enzyme immunoassay (EIA) test kits, and during the pilot-scale demonstration using an on-site gas chromatograph (GC) with an electron capture detector. These analytical procedures permitted rapid (1-hr) evaluation of system performance during treatment. Split samples of untreated soil, treated soil, and regenerated solvent were sent to an off-site laboratory to confirm the system's performance.

PCB concentrations in untreated soils for both demonstrations ranged from 17 to 640 mg/kg. The removal efficiency for both tests ranged from 95% to 99%. Treated soil concentrations for the NASNI Site 4 demonstration were consistently below 2 mg/kg. Only off-site laboratory data were reported, as these were subjected to the more stringent quality control review specified in the project quality assurance project plan.

The Terra-Kleen solvent extraction technology was evaluated based on the nine criteria used for decision making in the Superfund feasibility study process. Results of the evaluation are summarized in Table 1.

Under current TSCA regulations, only incinerators and Resource Conservation Recovery Act (RCRA) subtitle C-certified landfills have been permitted to dispose of PCB-contaminated soils. The SITE demonstration successfully demonstrated the Terra-Kleen system's ability to reduce the PCB concentration in soils to less than 2 mg/kg in accordance with EPA TSCA guidelines. The EPA Office of Pollution Prevention and Toxics (administrative authority for TSCA) is reviewing Terra-Kleen's permit application to treat PCB-contaminated soils. TSCA permit approval will enable Terra-Kleen to operate at RCRA, CERCLA, and private sites to remediate PCB-contaminated soils and provide owners of sites with an alternative to conventional disposal options.

Development of the Terra-Kleen system has continued into full-scale remedial operations. A full-scale system began operating in July 1994 on DDT-contaminated soils at NCS-Stockton. Information on full-scale operations and the evaluation of demonstration results will be published in the Innovative Technology Evaluation Report (ITER), which will be available from EPA.

Technology Description

The Terra-Kleen solvent extraction technology is a batch process system that uses proprietary solvents to separate organic contaminants from soils. The system also concentrates the contaminants, reducing the volume of hazardous wastes for final disposal.

Figure 1 presents a schematic diagram of the Terra-Kleen system that was used in the SITE pilot-scale demonstration. The system consisted of five extraction tanks (tanks A through E), a sedimentation tank, a microfiltration unit, a solvent purification station, a clean solvent storage tank, and a vacuum extraction system. Because solvents are flammable, pneumatic and spark-proof pumping systems transport the solvent and vapor through the system to maintain an intrinsically safe environment.

The Terra-Kleen treatment technology does not require soil screening equipment to remove oversized materials before treatment, although it may be advantageous to remove large rocks, debris, or objects too large for safe handling during loading and unloading of the treatment tanks. Oversized materials may be treated separately.

Multiple large extraction tanks (each with a 16- to 17-yd^3 capacity) are used to treat larger volumes of contaminated soils. The full-scale system in operation at NCS-Stockton consists of 19 roll-off units simultaneously treating about 250 tons of soil in a batch operation.

The system is transportable and can be configured to treat both small or large quantities of soil. Many of the system components are available from local vendors throughout the U.S., easing the logistics for mobilization in most locations.

Solvent Extraction

Treatment begins after the excavated soil is loaded into the extraction tanks. Clean solvent from the solvent storage tank is pumped into the extraction tanks. Soil and solvent are held in the extraction tank, allowing organic contaminants to solubilize in the solvent, separating them from the soil. The retention time in the extraction tanks is based on site soil characteristics and the results of treatability tests.

The contaminant-laden solvent is then transferred from the extraction tanks to the sedimentation tank. Suspended solids

Table 1. Evaluation Criteria for the Terra-Kleen Solvent Extraction Technology

	Criteria								
	Overall Protection of Human Health and the Environment	Compliance with Federal ARARS[a]	Long-Term Effectiveness and Performance	Reduction of Toxicity. Mobility, or Contaminant Volume Through Treatment	Short-Term Effectiveness	Implementability	Cost [b]	Community Acceptance	State Acceptance
System Performance Evaluation	Provides both short- and long-term protection by eliminating exposure to contaminants in soil.	Terra-Kleen system complies with TSCA incineration equivalency guidelines for PCB reduction.	The only waste product is a contaminant concentrate, which is either recycled, landfilled, or incinerated, depending on site-specific contaminants.	Toxicity and mobility are reduced with removal of the soil contaminants.	Contaminants are removed immediately upon completion of treatment, which ranges from 6 hours to several days, depending upon the number of wash cycles required.	Commonly available system components enable the Terra-Kleen system to be implemented at nearly any location.	$165 to $600 per ton of soil.	Absence of combustion stacks and use of some solvents that are approved as food additives by the FDA has positive community appeal. However, solvents are flammable.	California Environmental Protection Agency Department of Toxic Substance Control approved implementation of the pilot projects.
	Solvents must be removed from soils prior to replacement on site.	Emission controls must be in place to comply with volatile organic emission restrictions of the Clean Air Act. Regional restrictions will vary.	Effectively removes contaminant-, ion eliminating any long term contaminant effects.	Volume reductions depend on the concentration of contaminants in the soils to be treated. Lower levels of contamination in untreated soils should yield a higher ratio of contaminant waste volume reduction.		System can be assembled in 3 days and removed in 1 day for small-scale systems. Minimal site preparation is required. Total operating time can be extensive if numerous wash cycles are required.		Minimal short-term risks presented to the community and absence of long-term risks have favorable impact.	State and local permits must be obtained to comply with air emission restrictions and to store soils and solvents for greater than 90 days if extended operations are planned.
	Worker protection required when handling contaminated laboratory or site wastes and contaminant concentrates.	Requires compliance with RCRA treatment, storage, and land disposal regulations.	Solvent residuals readily biodegrade.			The system has been demonstrated only on soils containing less than 15% clays.			

Notes:

a ARARS = Applicable or relevant and appropriate requirements

b Actual cost of remediation is specific to individual sites. Reported cost per ton is a range based on treatment of 1,000 yd^3 of soil.

One yd^3 of NASNI soil = 1.5 tons.

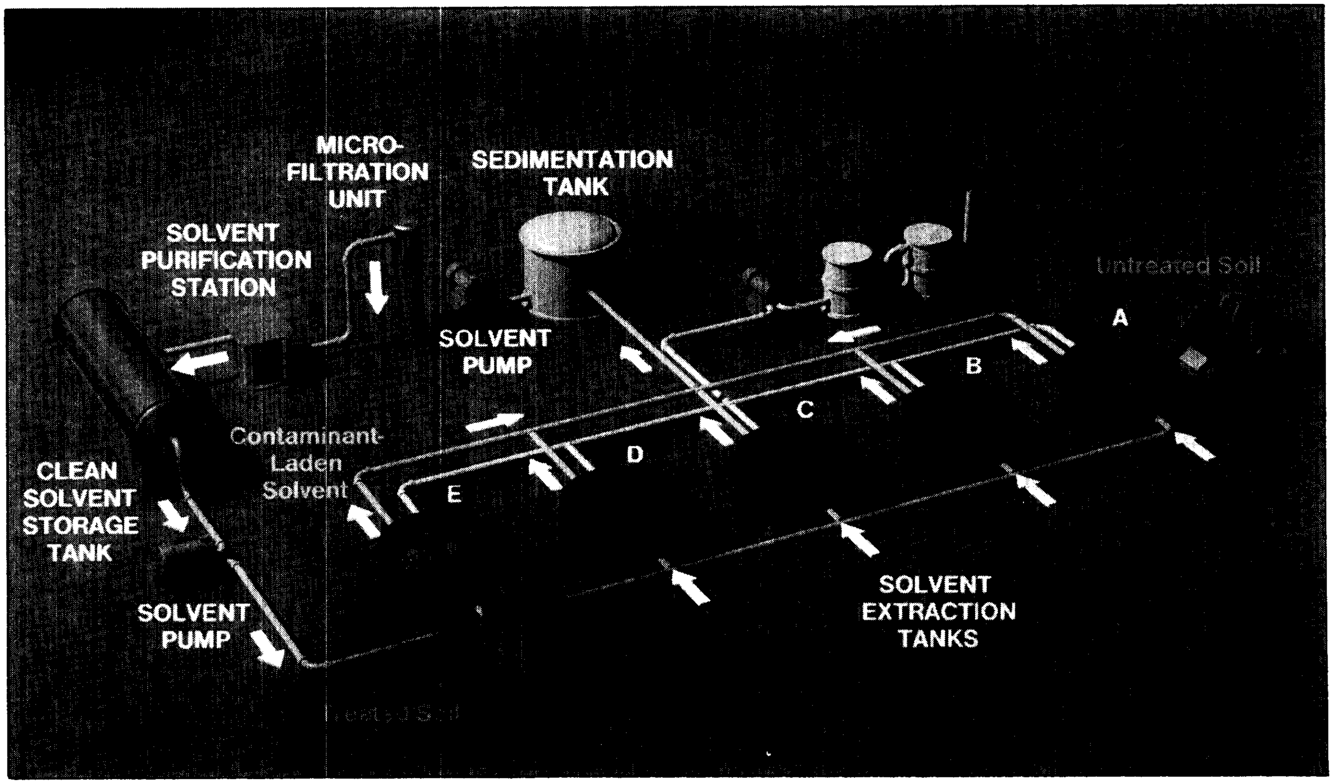

Figure 1. *The Terra-Kleen solvent extraction technology as demonstrated.*

that settle or coagulate in the sedimentation tank are removed and tested for contaminant content. When the solids are confirmed clean, they are added to the treated soil.

Solvent washes continue until a site-specific soil cleanup level is attained. On-site GC and EIA equipment is used to monitor organic concentration levels during treatment. Wash solvent and treated soil are analyzed to measure the progress of contaminant removal. Final treatment levels are confirmed by off-site GC analysis.

Residual Solvent Removal

Following the solvent washes, any residual solvent in the soil is removed using vacuum extraction and biological treatment. Vacuum extraction removes most residual solvent by drawing a vacuum on the extraction tank using a centrifugal blower. During the demonstration solvent vapor and air were drawn out of the tanks through a condenser and liquid filter, and vented to the atmosphere. Full-scale operations recirculate treated air back to the extraction tanks.

Following vapor extraction, an active biological culture and nutrient media are introduced to the treated soil to biodegrade residual solvent. After biological treatment, treated soils are replaced on site.

Solvent Regeneration

The solvent regeneration process begins by pumping contaminant-laden solvent from the sedimentation tank through the microfiltration unit and the proprietary solvent purification station. The microfiltration unit removes fines remaining in the solvent. The solvent purification station separates organic contaminants from the solvent and concentrates them, reducing the volume of hazardous waste for off-site disposal.

Regenerated solvent is then pumped into the clean solvent storage tank for use in subsequent wash cycles. During the demonstration and treatability studies, solvent exiting the solvent purification station was sampled to confirm that PCBs were removed.

The Terra-Kleen system concentrates soil contaminants using the solvent purification process. Concentrated contaminants are removed for disposal. The chemical contaminants contained in the concentrate determine the acceptable disposal method.

Technology Applicability

The Terra-Kleen solvent extraction technology is a waste minimization process designed to remove the following organic contaminants from soils: PCBs, petroleum hydrocarbons, chlorinated hydrocarbons, polynuclear aromatic hydrocarbons (PAH), polychlorinated dibenzo-p-dioxins (PCDD), and polychlorinated dibenzofurans (PCDF). The technology's capacity for removing other organic contaminants, such as pesticides, has been successfully implemented at full-scale capacity as part of the remediation activities at NCS-Stockton.

The entire treatment system is transportable and can be configured to treat a few cubic yards of soil as well as much larger volumes generated at remedial sites. Pilot systems have been tested with 1-ton and 5-ton treatment volume capacities. A 250-ton system configuration is currently in operation.

Treatability tests are typically conducted before field implementation to ensure the system's capability to achieve the desired remedial goals. Site-specific cleanup levels and contaminant concentrations are the primary determinants for the number of wash cycles and cycling time required to clean a particular soil type. In general, as site-specific soil contaminant concentrations increase, and remediation target concentrations become more restrictive, more wash cycles and longer washing times are required to reduce contamination. Treatability tests have shown a wide range of washing cycles required to reduce soil concentrations to target levels, depending on the specific soil contaminants and resident soil types.

Treatability results from the NCS-Stockton site have shown that the Terra-Kleen system can reduce pesticides in soil from 450 to 0.192 mg/kg after only 3 wash cycles. However, 57 wash cycles were required to lower PCB concentrations in the Alaska soil from 300 to 6.0 mg/kg (see Table 2). The difference in the number of wash cycles required to complete contaminant removal in these two cases is influenced by soil particle size, moisture content, organic content, contaminant concentrations, contaminant mixtures, and contaminant identity.

Optimal soil conditions for treatment include soil containing less than 15% clay and less than 20% moisture. Higher clay concentrations require additional wash cycles and physical handling to reduce clay aggregate size. Higher moisture content requires soil drying and solvent distillation to reduce water accumulation in the solvent.

Technology Limitations

Contaminated soils with greater than 15% clays or fines are difficult to treat because contaminants are strongly sorbed to the soil particles. The soil particles also tend to form tight aggregates, which are difficult to break up and prevent efficient penetration of the solvent to transport contaminants out of the soil. Additional soil handling steps may be required to treat soils with a high clay content.

Soils containing more than 20% moisture must be dried prior to treatment. Excess water dilutes the solvent, reducing contaminant solubilization and transport efficiency. Water buildup in the stock solvent requires the addition of a distillation step to maintain solvent integrity. If volatile soil contaminants are present, soil must be dried in the closed extraction vessel. Soils are typically placed in the extraction tanks by heavy equipment. The potential for fugitive particulate and volatile emissions must be considered during excavation and soil handling activities.

The system did not remove metals. Inorganic analyses and leachate tests conducted on treated soils during the treatability study showed no change in inorganic or metal-leaching characteristics after soil treatment.

The system is currently designed to operate at ambient outdoor temperatures above freezing. Cold temperatures reduce

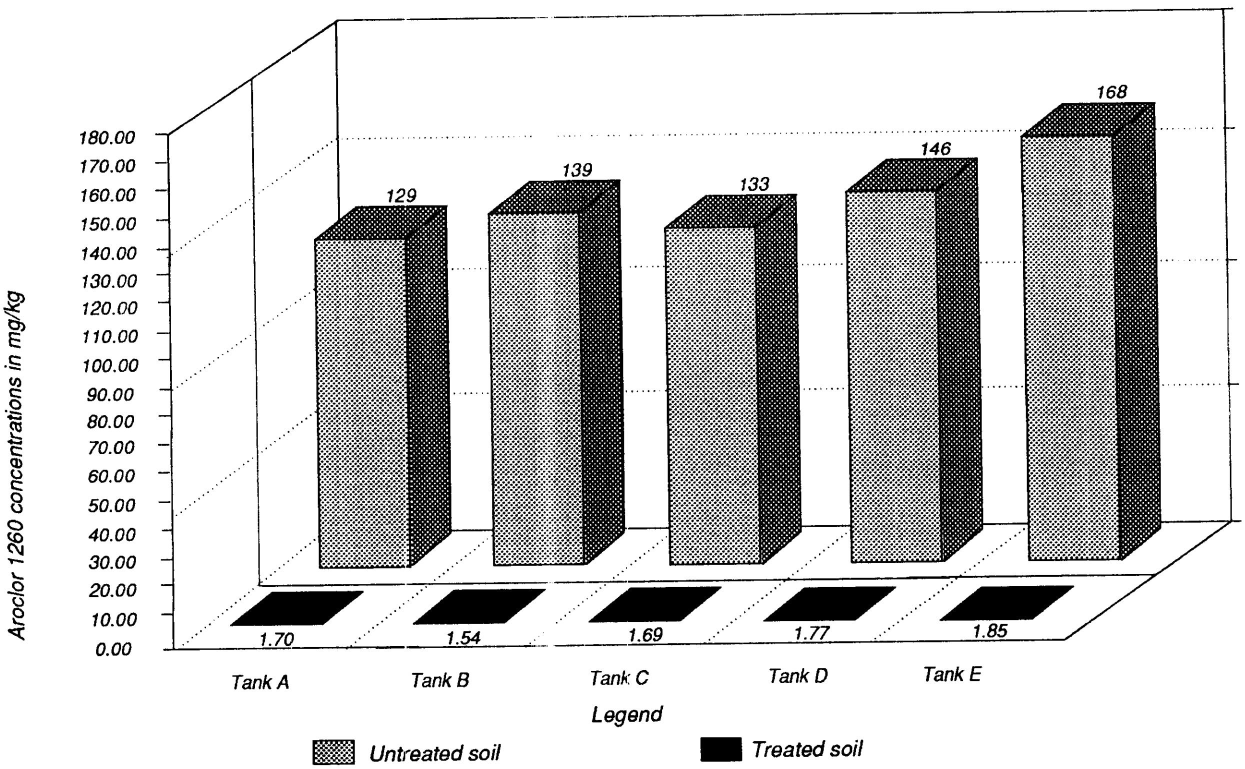

Figure 2. *Aroclor 1260 concentrations in untreated and treated soils.*

solvent mobility. While current modifications to the full-scale system incorporate a closed-loop heated vapor extraction system, the extraction tanks themselves are not jacketed, and operation in extreme cold weather can impede extraction efficiency. In cold climates, a heated enclosure may be necessary to implement all-weather operations.

Process Residuals

The Terra-Kleen solvent extraction technology maximizes its waste reduction potential by (1) recycling the extraction solvent as part of routine system operations, (2) maintaining a closed-loop process to reduce volatile emissions, and (3) isolating its waste streams to a proprietary contaminant-laden concentrate. Five tons of soils were treated during the pilot-scale demonstration, generating three 55-gal drums of concentrate. The contaminant concentration process had not reached its capacity as evidenced by the absence of PCBs in the regenerated solvents. Further evaluations will be performed to project the system's theoretical volume reduction capacity. The results of these evaluations will be presented in a Terra-Kleen Innovative Technology Evaluation Report (ITER).

Of the 1100 gal of stock solvent used for the SITE demonstration, about 930 gal were drummed at the conclusion of the demonstration. The majority of unrecovered solvent remained as residuals in soil and in the bottoms of the extraction tanks and pipelines. Under normal system operations, these final residuals would also be removed and recovered. Terra-Kleen reports that under normal operating conditions, the treatment process consumes about 7 gal of solvent per ton of soil. Terra-Kleen is researching vendors who will accept the purified solvent for sale in secondary markets, enabling nearly complete reuse.

Treated soils can be replaced on site once solvent residuals have been reduced. The biological half-life of the solvent is 3 days. However, the solvent extraction process will remove natural organic and some inorganic biological nutrients such as nitrates and phosphates. Therefore, a nutrient supplement containing natural organic and inorganic nutrients may be required to continue residual solvent degradation after the soil is replaced on site.

During the pilot-scale operations, air emissions, consisting primarily of solvent vapors, were released when sampling and biological treatment activities required removal of the extraction vessel's lids. Full-scale system configuration incorporates a completely enclosed design that enables treatment without exposing the soil to the open air. In addition, an internal combustion engine fueled by solvent vapors can be used during all vapor extraction operations to treat vapor emissions prior to recycling them back to the extraction tanks.

Site Requirements

Site requirements for the Terra-Kleen system range from 300 ft^2 for small-scale, single extraction vessel configurations for treatability studies to 4,000 ft^2 for larger operations, such as those implemented at NCS-Stockton.

Fluid pumping systems are pneumatically driven by a 5-hp compressor. Vapor extraction pumps are electric, 3-phase, 220-volt systems that operate continuously during vapor extraction activities.

Sufficient water supplies are also required to mix the biological slurries for final solvent consumption. The 1-ton vessels at NASNI required about 20 gal per vessel. Future changes in biological degradation procedures may increase water consumption.

Performance Data

The primary objective of both the treatability study and pilot-scale demonstration was to determine the Terra-Kleen technology's effectiveness in removing PCBs from soil. The TSCA incineration equivalency performance guidance level of 2 mg/kg of PCBs was used as a target treatment level for system evaluation.

To provide additional information on the technology's capabilities, samples were also collected and analyzed for volatile organic compounds (VOC), semivolatile organic compounds (SVOC), PCDDs, and PCDFs. However, PCDD and PCDF concentrations in untreated soils were at or near their detection limits (0.6 ng/g). Detection limits in treated soils for VOCs

Table 2. *Analytical Results for the Terra-Kleen Treatability Study*

	NASNI Site 4	*NASNI Site 6*	*Alaska Site*
PCBs in Excavated Soil (mg/kg)	*Not reported* [a]	*260*	*300*
PCBs in Untreated Soil (mg/kg) [b]	*17*	*28*	*640*
PCBs in Treated Soil (mg/kg) [b]	*0.78*	*1.4*	*6*
Percent Removal	*95*	*95*	*99*
Percent Clays and Fines Less Than .075mm in Untreated Soil	*3.51*	*7.92*	*14.46*
Percent Moisture in Untreated Soil	*0.4*	*1.3*	*15*
Percent Total Volatile Solids in Untreated Soil	*0.16*	*0.34*	*0.65*
Number of Wash Cycles	*12*	*24*	*57*

Notes: [a] *Laboratory quality control values were outside acceptable range.*
[b] *PCB as Aroclor 1260 in mg/kg reported as dry weight*

(maximum 0.339 mg/kg) and SVOCs (maximum 0.675 mg/kg) were greater than the concentration of these compounds in untreated soil. Consequently, this data was inadequate for evaluating system performance on these contaminants.

Treatability Study

The treatability study was conducted at the Terra-Kleen facility in Okmulgee, OK, in October, 1993. The system used in the study was a small pilot-scale system comprosed of a single 1-ton extraction tank. Site soils were treated one batch at a time, with washes running 3 to 11 days depending on contaminant concentrations. Table 2 presents the results of the treatability study.

Soils used for these treatability tests were excavated from the areas at each site with the highest reported PCB concentrations. Composite samples were then taken from each pile of excavated soil before shipment to Okmulgee, OK.

Excavated soil was placed in drums for shipment, transported by overland carrier, and delivered to the Okmulgee location. Drummed soils were then hoisted over the extraction tank and dumped. Soils were composited, sampled, and analyzed in accordance with EPA guidance for sampling PCB spill sites to document the effects of soil transport on the distribution of PCBs in soil.

During soil treatment, EIA tests were used on site to monitor PCB concentrations in soil and solvent. Split samples of treated soil and solvent were analyzed by an off-site laboratory for reporting final data.

Treatability Study Results

PCB removal was effectively demonstrated in all treatability study tests; for all three sites, contaminants were concentrated by the solvent purification process. Regenerated solvent did not contain PCBs above the detection limit (33.6 µg/kg), enabling it to be used in subsequent wash cycles.

A large difference in PCB concentrations was documented between excavated soil samples and untreated soil samples. The discrepancy in PCB concentrations in untreated and excavated soil was attributed to variable PCB distribution in the soils and mixing with surrounding soils that contain lower or higher PCB concentrations. Percent removal of PCBs was calculated using the untreated soil samples because these samples were considered more homogenous and representative of treated soils than the excavated soil.

The required treatment time increases with contaminant concentration, as shown by the number of wash cycles for the three soils. The Alaskan soil contained a greater percentage of soil fines and clay than the NASNI soils. Total volatile solids analysis of untreated soils and visual observations also indicated a higher percentage of natural organic material. These factors may have contributed to the need for additional wash cycles. Terra-Kleen's experience with these soil conditions confirms that these soils' physical parameters affect the number of wash cycles needed to complete contaminant removal.

The Alaskan soil also required air drying to reduce soil moisture prior to treatment. This additional step prevented excess moisture from accumulating in the solvent during soil treatment and solvent purification.

Pilot-Scale Demonstration

The pilot-scale demonstration took place at NASNI from May 2 to June 16, 1994. NASNI is located at the northern end of the peninsula that forms the San Diego Bay. NASNI was officially commissioned in 1917 as a support facility to provide services and material for aviation activities and naval operations. Large quantities of hazardous waste were generated and disposed of at NASNI after the United States entered World War II.

As part of NELP, NASNI contracted Terra-Kleen to treat about 5 tons of PCB-contaminated soil. The demonstration was conducted at Site 4, which is one of 12 areas identified for further investigation under NASNI's Installation Restoration Program. Site 4 consists of a 3-acre, unpaved, former salvage yard, located next to a golf course. The site was used to store miscellaneous materials, including electrical transformers containing PCBs. Soils at Site 4 are contaminated with heavy metals, VOCs, SVOCs, PCBs (Aroclor 1260), dioxins, and furans.

Soils from a small area of Site 4 containing high concentrations of PCBs were excavated and homogenized for use in the demonstration. The soils were homogenized before being loaded into the five extraction tanks, so that the PCB distribution would be similar in each tank.

Pilot-Scale Demonstration Results

Terra-Kleen conducted 11 wash cycles in 7 days. Solvent washing was discontinued when PCB concentrations in the five extractions tanks were reported at 0.52 to 0.69 mg/kg by on-site GC. Vacuum extraction and biological treatment of the soils continued for two additional weeks. Table 3 presents preliminary results for treated soils.

Results of off-site laboratory analyses showed that the treated soils contained about 5% moisture caused by incomplete draining of the treated soils after biological treatment. The moisture consisted of both water and residual solvent. The demonstration time limits prevented completion of the solvent removal process. Therefore, the presence of residual moisture in the treated soils is not necessarily representative of system performance.

Analytical results from the on-site laboratory indicated that solvent concentration in soils after biological treatment ranged from 5,144 mg/kg to 18,321 mg/kg. Results of stratified samples collected at the top and bottom of tank A confirmed the presence of residual solvent in the bottom of the tank.

The off-site laboratory separated the residual solvent and water from the treated soil to determine if both matrices contained PCBs and to determine how the residual moisture affected PCB concentrations in treated soils. These additional analyses indicated that the residual moisture contained PCBs that contributed to the treated soil concentrations reported in Table 3. Table 4 presents data for treated soils without the moisture component.

Repeat analyses confirmed these findings. The ITER will include recommendations that ensure accurate monitoring of technology performance; the ITER will also address how final contaminant concentrations are reported when residual solvent and moisture are present in treated soils.

Table 3. *Results for the Pilot-Scale Terra-Kleen System*

	PCB Concentrations as Aroclor 1260 in mg/kg (wet weight)				
	Tank A	Tank B	Tank C	Tank D	Tank E
Untreated	129	139	133	146	168
Treated Soil	1.70	1.54	1.69	1.77	1.85
Percent Removal	98.7	98.9	98.7	98.8	98.9

Table 4. *PCB Concentrations in Treated Soils Without Moisture*

	PCB Concentrations as Aroclor 1260 in mg/kg (wet weight)				
	Tank A	Tank B	Tank C	Tank D	Tank E
Treated Soil Without Moisture	1.18	1.43	1.25	1.36	1.78
Percent Removal Without Moisture	99.0	98.9	99.0	99.0	98.9

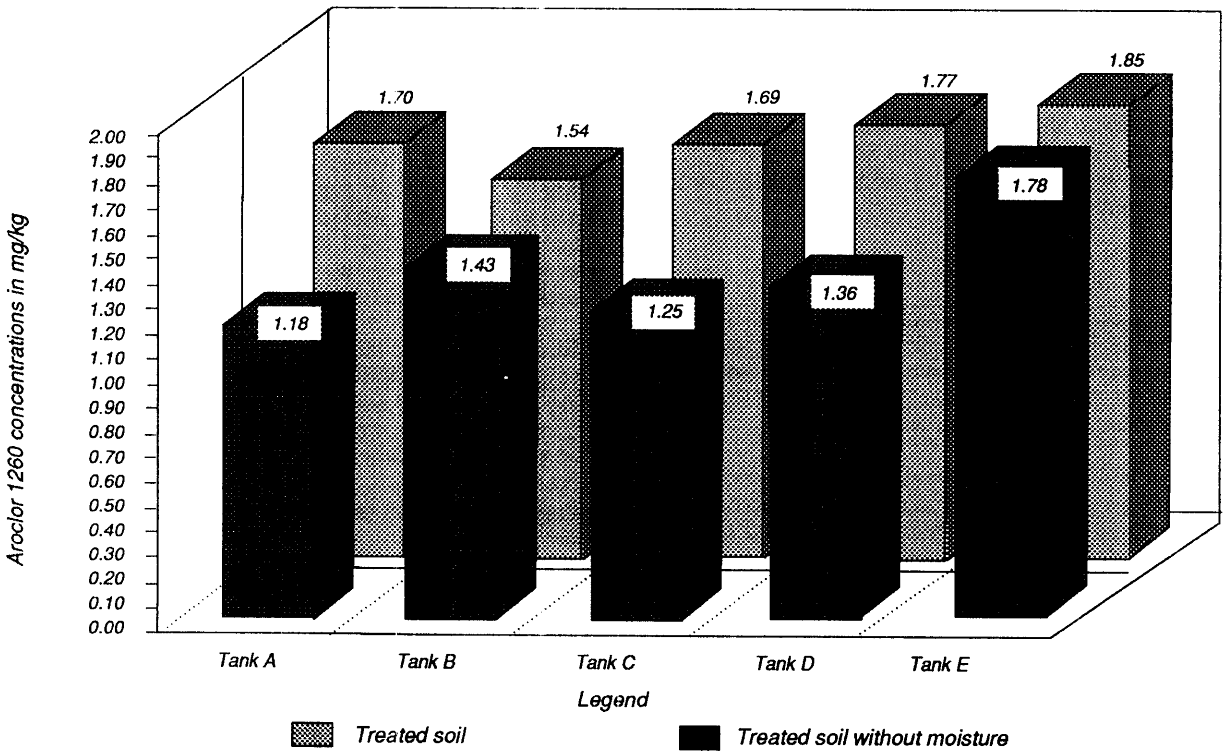

Figure 3. *Aroclor 1260 concentration in treated soil and treated soil without moisture.*

Table 5. *Pesticide Removal for the Full-Scale Terra-Kleen System*

	Average Pesticide Concentrations in mg/kg		
	DDD	DDE	DDT
Untreated Soil	12.2	1.5	80.5
Treated Soil	0.024	0.009	0.093
Percent Removal	98.0	99.4	98.8

Changes in PCB concentrations from solvent extraction and laboratory soil washing are graphically illustrated in Figures 2 and 3. These illustrations show the system's consistent effectiveness at treating the soils in all five tanks. Figure 3 shows the effect of residual solvent on treated soil concentrations.

Successful completion of the pilot-scale study enabled Terra-Kleen to implement a full-scale system to remediate a pesticide-contaminated site at NCS-Stockton. The analytical results of samples collected from the first 20-yd^3 container of soil are shown in Table 5. The pesticides were removed in three wash cycles.

Technology Status

Completion of the pilot-scale demonstration at NASNI has encouraged the U.S. Navy to select Terra-Kleen to implement full-scale remediation at three PCB-contaminated NASNI sites, totalling about 5,000 yd^3 of soil. Remediation is scheduled to begin in 1995. NCS-Stockton selected Terra-Kleen to implement full-scale treatment of 500 tons of pesticide-contaminated soil. Upon successful completion of the first phase of work, several thousand tons of material will be treated. Terra-Kleen plans to expand the holding capacity of the NCS-Stockton treatment system from 250 to 500 tons, based on successful start-up operations. Terra-Kleen has also implemented improved emission control methods to contain fugitive solvent emissions.

Source of Further Information

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